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# 10 Seal Coat Placement

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# CHAPTER TEN:

## *SEAL COAT PLACEMENT*

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Seal coating consists of the application of liquid asphalt material to the roadway followed immediately by the application of the aggregate. Sometimes seal coats are referred to as chip seals. Seal coat applications may include single or double coverage. Where double applications are used, the first application of asphalt material is covered with aggregate, rolled, and allowed to cure before the second coat is applied.

Seal Coats are covered in Section **404**. Seal coats may be applied to aggregate or HMA surfaces; however, the most common use by INDOT is on HMA surfaces. When a seal coat is placed on an aggregate surface, a prime coat (Section **405**) is first applied and allowed to cure.

Seal coats are applied to HMA surfaces to:

- 1) Seal out moisture and air
- 2) Rejuvenate dry weathered surfaces
- 3) Improve skid resistance of the pavement
- 4) Improve visibility of delineation between the traveled way and the shoulders

Seal coats applied directly to roadways with aggregate surfaces provide a smooth, dust-free traveled way which eliminates the need for periodic re-grading of the surface. This method of construction is normally used only for low-volume roads.

INDOT typically uses seal coats on travel lanes on low volume roads or on shoulders of roads of any traffic volume.

Fog seals are sometimes used in conjunction with seal coats. A fog seal is a light application of liquid asphalt material to a pavement surface and is commonly used on seal coated pavements to improve the cover aggregate retention, assist the curing, and improve surface appearance. INDOT most commonly uses fog seals on seal coated surfaces.

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## TYPES OF SEAL COATS

Seven types of seal coats are used as indicated in the table below. The types vary by the size of cover aggregate used and the number of applications. Types 1 through 4 use single applications and types 5 through 7 are double applications.

Type	Application	Cover Aggregate Size No.	Rates of Application per Square Yard	
			Aggregate (lb)	Asphalt Material (Gallons at 60°F)
1 or 1P	Single	23, 24	12-15	0.12-0.16
2 or 2P	Single	12	14-17	0.29-0.33
3 or 3P	Single	11	16-20	0.36-0.40
4 or 4P	Single	9	28-32	0.63-0.68
5 or 5P	Double	Top – 12	16-19	0.33-0.37
		Bottom - 11	16-20	0.36-0.40
6 or 6P	Double	Top - 11	18-22	0.41-0.46
		Bottom - 9	28-32	0.63-0.68
7 or 7P	Double	Top - 11	18-22	0.41-0.46
		Bottom - 8	28-32	0.63-0.68

Seal coat types which include a "P" in the designation utilize a polymer based asphalt material, AE-90S. INDOT requires polymer modified emulsion on all highway mainline applications. HFRS-2 is not to be used with a Type I Seal Coat. Additional requirements related to allowable asphalt materials for other seal coat types are included in Sections **404.03**, **404.04**, and **902.01(b)**. Seal coat asphalt materials require a Type A certification for acceptance by INDOT.

For double applications, the coarser aggregate is used for the first application. Section **904** includes the requirements for the aggregates used in seal coats. The cover aggregates are required to be produced by a CAPP approved source.

## QUALITY CONTROL PLAN

A quality control plan which outlines the proposed seal coat operation is required to be approved prior to beginning work. The QCP shall be in accordance with **ITM 803** (Appendix A).

## EQUIPMENT

Four major pieces of Contractor equipment are required for seal coating: a distributor, chip spreader, pneumatic-tired roller, and rotary power broom.

### *DISTRIBUTOR*

The asphalt distributor (Figure 10-1) is the most important piece of equipment on a seal coat operation. The uniform application of the asphalt material at the appropriate rate is essential to achieve a quality seal coat.

The distributor is required to be checked to ensure that the equipment is in good working condition and complies with the Specification requirements. The proper nozzles, nozzle angles, spray bar height, pump speed, and pump pressure are items that are required to be checked. Clogged nozzles are a common problem that prevents a uniform application of asphalt material on the pavement surface. If the distributor does not apply a uniform application of emulsion over the entire surface to be seal coated, the operation is stopped immediately until the problem is corrected.

The distributor operation is optimized to ensure that the asphalt material is applied to the pavement surface at the appropriate rate. Proper asphalt material application rates vary depending on the existing pavement condition. To achieve the required application rate, the distributor pumps and speeds are required to be coordinated properly.



**Figure 10-1. Asphalt Distributor**

### ***CHIP SPREADER***

The chip spreader (Figure 10-2) receives the aggregate from the haul trucks and deposits the material uniformly over the full width of the asphalt material applied by the distributor. The spreader is required to spread the material uniformly without segregation so that the larger particles are applied to the surface ahead of the finer material.

Chip spreaders usually are self-propelled. Tailgate spreaders that hook onto dump trucks may be used for small quantities.



**Figure 10-2. Chip Spreader**

### ***PNEUMATIC-TIRE ROLLER***

The purpose of rolling with a pneumatic-tire roller (Figure 10-3) is to seat the aggregate into the asphalt material. Care is required to be taken in rolling to avoid moving the chips during the rolling process. A smooth, uniform operation of the roller is essential. Excessive braking, fast starts, or sharp turns may dislodge the cover aggregate from the asphalt material. Pneumatic-tire rollers are required to be ballasted to the proper weight and the tires properly installed.

The chip spreader and the pneumatic-tire roller should remain as close to the distributor as possible. The intent of a seal coat operation is to place and seat the cover aggregate into the asphalt material prior to the break that occurs as water evaporates from the emulsion. Prior to the break, the asphalt material is brown in color. After the water evaporates from the emulsion, the color of the material will be black.





**Figure 10-3. Pneumatic-Tire Roller**

***ROTARY POWER BROOM***

A power rotary broom (Figure 10-4) is required for cleaning the surface prior to seal coating and to remove excess cover aggregate within 24 hours after the seal coat application. Power brooms may be self-propelled, mounted on the front of tractors, or mounted on trailers pulled behind other vehicles. Some manufacturers make special machines for this purpose.



**Figure 10-4. Rotary Power Broom**

## **SURFACE PREPARATION**

Surface preparation is extremely important for successful seal coating. The surface is required to be clean, dust free, and dry to obtain proper adhesion of the seal coat. Preparation of the surface varies somewhat, depending on the type of surface.

### ***AGGREGATE SURFACE***

Aggregate surfaces are required to be brought to the proper crown and grade and thoroughly compacted. Aggregate surfaces that have been under traffic typically have potholes and chatter bumps (washboarding) which are required to be removed. Removal may be done by scarifying a minimum of 3 in. deep, reshaping, and re-compacting. The surface is required to be free from all ruts, corrugations, segregated material, or other irregularities.

### ***PRIME COATS***

A prime coat is the application of asphalt material to an aggregate, stabilized base, or similar absorptive base that is to be given an asphalt surface. The purpose of the prime coat is to act as a bonding agent between the base and the seal coat. Prime coat materials penetrate into the base a slight amount to help hold down the dust which would prevent the seal coat from sticking. Prime coats are only used when a chip seal is applied to an aggregate surface.

Prime coats may be applied only when the temperature is 50° F or higher, unless written permission is given by the PE/PS. The existing surface is required to conform to the requirements for an aggregate pavement, as described in Section **303**, before the prime coat is applied.

The asphalt material for a prime coat is required to be applied uniformly with a distributor at the specified temperature. The rate of application may vary from 0.25 to 0.80 gallons per square yard depending on the condition of the surface and the kind, gradation, and amount of loose aggregate. Skipped areas are required to be corrected and any excess material removed from the surface. Building paper is required to be placed over the ends of previous applications and the joining application started on the paper to prevent excess material build-up. The prime coat is cured when the material ceases to be tacky, usually within 24 hours. If the prime coat does not penetrate after a reasonable time and the primed area is required to be opened to traffic, cover aggregate is spread to absorb the excess material. When traffic is required to be maintained not more than one-half of the width of the roadway may be primed at one time.

## ***HMA SURFACES***

All defective areas and broken edges of existing HMA surfaces are required to be repaired prior to sealing. The old surface is brought to a reasonable degree of uniformity by correcting flushed or dry areas and patching potholes and dips.

Cleaning the existing surfaces may normally be done with a power rotary broom. However, mud or other foreign matter may require removal with shovels, hand brooms, or water.

## **PLACEMENT**

### ***WEATHER LIMITATIONS***

The best weather for seal coating is hot and dry, during and after the application. Sealing is never started when the surface is wet or rain is threatening. The Specifications require that both the air and surface temperatures be at least 60°F. In addition to the temperature restrictions, seal coats may only be applied to the mainline pavement between May 1 and October 1. Shoulders are not subject to these date limitations.

Special care is required to protect the traveling public from over-spray from the distributor in windy weather. Sealing is not allowed in strong winds because crosswinds disturb the flow of asphalt materials from the nozzles which may cause spray interference and streaking.

### ***TRAFFIC CONTROL***

Because seal coats are often applied to road surfaces under traffic, special traffic control measures are needed. The seal coat is required to be protected from the traffic until the material has cured enough to prevent pick-up or displacement of the cover aggregate and until the chips are firmly embedded.

Traffic control is usually done during the initial curing period by the use of flagmen and pilot cars. Later, the traffic control may be handled with signing. Traffic is piloted through the work at speeds low enough to prevent damage to the newly placed seal coat. Normally, the speed should be less than 25 miles per hour. Care is required to be taken to prevent sudden starts or stops on the new seal. When stopping traffic on a new seal coat, additional cover aggregate at the stop locations may be necessary to prevent pick-up of the cover aggregate and tracking of the asphalt material.

The length of time that traffic is controlled depends on the weather and the type of asphalt applied. During cool, damp, cloudy, or humid weather, longer control periods are necessary than when the weather is warm, dry,



and sunny. Cool, damp weather delays the evaporation of the moisture in the cover aggregate and the setting rates of the asphalt material. During very hot weather, traffic is controlled longer if there is a possibility of chips rolling or picking up under traffic. Traffic is controlled during that portion of the day when damage may occur to vehicles due to flying rocks or to the seal coat. Traffic control may be necessary during the second day after seal coat placement.

Following an unexpected rainstorm, traffic is kept off of the new seal coat until the cover aggregate has dried. If this is not possible, controlling traffic at an extremely slow rate is necessary and rolling is not continued until the danger of dislodging the aggregate has passed.

Traffic control is provided and the work scheduled to handle the traffic with a minimum delay. Most extended delays, exposure of the traffic to unnecessary hazards or inconveniences, or damage to the seal coat are the result of poor planning for traffic control. Traffic is never allowed to pass a distributor which is applying asphalt material if there is any possibility of asphalt being sprayed on the vehicles.

#### ***APPLICATION OF ASPHALT MATERIAL***

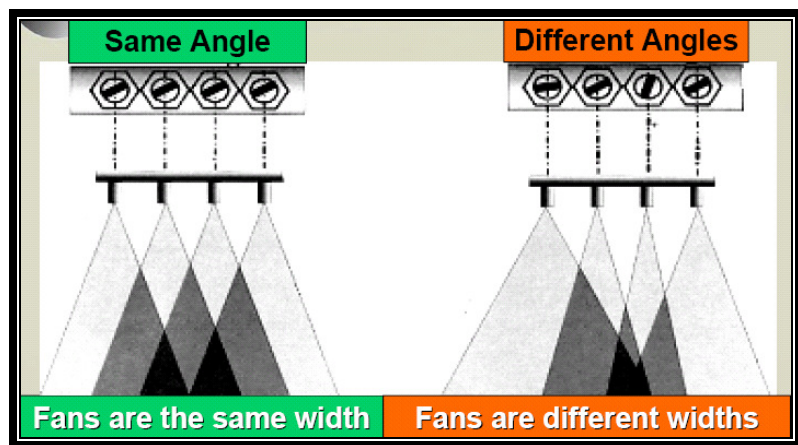
Asphalt material is applied to the roadway with a pressure distributor to obtain a uniform application. The distributor is required to heat the material to the designated temperature range. A continuous, uniform application of the asphalt material over the width to be sealed is required for a good seal coat. The distributor is tested for uniform application prior to beginning the sealing operation. The distributor is required to not be more than one minute ahead of the chip spreader.

The biggest problem in applying asphalt materials is the prevention of streaking. Streaking results in alternating areas with an excessive amount of asphalt immediately adjacent to one with insufficient asphalt and is usually caused by one of the following conditions:

- 1) Asphalt at the improper temperature
- 2) Interference of the sprayed material from one nozzle with that of adjacent nozzles
- 3) Improper pump speed
- 4) Improper spray bar height
- 5) Clogged nozzles

The required corrective actions for the above conditions are as follows:

- 1) Maintain the temperature of the asphalt material at the high end of the range suggested by the emulsion supplier.
- 2) Orient all nozzle openings in accordance with the manufacturer's recommendations. All nozzles are set at the same angle to prevent interference (Figure 10-5). Special wrenches are available to ensure that the nozzles are aligned uniformly. Generally, the smaller the nozzle opening, the more uniform the application of asphalt material. Worn or damaged nozzles are required to be replaced.



**Figure 10-5. Distributor Nozzles**

- 3) The highest possible pump speed that does not cause distortion of the spray fan is the correct speed to use. Low speed applications result in streaking and non-uniform discharge. Manufacturers provide charts and data for proper pump speed or pressure and for determining the discharge in gallons per minute for each nozzle size.
- 4) Clogged nozzles are usually the result of allowing the spray bar to cool between applications. This causes the material at the bar to harden. Circulating the hot material through the spray bar until the bar reaches the temperature of the material generally melts the obstruction. A quick test shot before starting is recommended.
- 5) Improper spray bar height is the principal cause of streaking. Visual observation while the distributor is moving does not reveal whether an exact double or triple lap is being applied. Without prior checking, only time reveals the lack of uniformity of the seal coat application.

The optimum spray bar height is also dependent on the bar's nozzle spacing. The spray bar height/nozzle spacing combination should produce either an exact double or triple overlap of the adjacent fans. Generally, closer nozzle spacings are required to achieve triple overlaps. When the proper spray bar height/nozzle spacing combination is achieved, the distributor will be able to maintain the spray bar height regardless of the amount of asphalt material in the tank.

### ***Transverse Joints***

Irregular transverse joints may be avoided by starting and stopping the application of the asphalt on building paper. The paper is placed across the lane to be treated so the forward edge is at the desired location. The distributor, traveling at the correct speed for the desired application rate, starts spraying on the paper so there is a full uniform application when the exposed surface is reached. A second placement of paper is made across the lane at the predetermined cutoff point for the distributor. This procedure gives a straight, sharp transverse joint. After the aggregate spreader has passed over the building paper, the paper is removed and discarded.

For the next application, the leading edge of the paper is placed within 1/2 in. of the cutoff line of the previously laid treatment. This procedure prevents a gap between the two spreads.

### ***Longitudinal Joints***

Full-width applications of asphalt and aggregates eliminate longitudinal joints. In most seal coat work, the joint is unavoidable because the roadway is too wide for one pass or traffic lanes are required to be maintained.

To prevent aggregate from building up on the longitudinal joints, the edge of the aggregate spread is required to coincide with the edge of the full thickness of applied asphalt. This procedure allows a width where asphalt is present in partial thickness to be overlapped when asphalt is applied to the adjacent lane. The partial thickness is the result of the outside nozzle spray being only partially overlapped. In this way there is no build up at the joint when the aggregate is spread for the full width in the next lane. The width of the asphalt strip left exposed varies depending on the nozzle spacing and whether the asphalt is a double or triple lap spray pattern.

If possible, the longitudinal joint is required to be along the centerline of the pavement being treated. An established line ensures a straight longitudinal joint.

The distributor is parked off the roadway when not in use so the spray bar or mechanism does not drip asphalt materials onto the traveled way, either before or after seal coating.

#### ***APPLICATION OF COVER AGGREGATE***

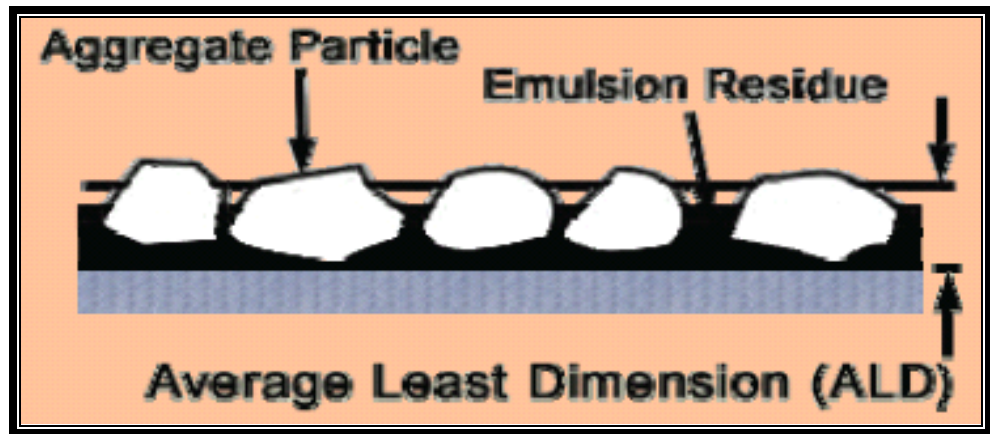
Cover aggregate is required to be clean and sufficiently dry so that a satisfactory bond with the asphalt material is obtained. If the aggregate is dusty, the material is moistened with water to eliminate or reduce the dust coating on the aggregate at least 24 hours prior to use. The moisture content should not exceed 3 %.

When the distributor moves forward, the aggregate spreader is required to follow immediately. To minimize the number of transverse joints, a sufficient number of trucks should be available to transport the cover aggregate to the job site. The cover aggregate is required to be applied within 1 min of the application of the asphalt material. The aggregate is required to be spread such that the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied asphalt material. In a single application, aggregate normally does not stick to the asphalt more than one particle thick; therefore, applying aggregate at a rate greater than a single layer is wasteful.

Rolling seats the aggregate in the asphalt and promotes the bond necessary to resist traffic stresses. One pass forward, one pass back, and another pass forward again are required over each area. Pneumatic-tired rollers are required for seal coating. Steel-wheel rollers generally only compact the high spots and may crush the aggregate. Pneumatic-tired rollers apply uniform pressure over the entire area.

Immediately after the cover aggregate is spread but before rolling, any area with a deficiency or surplus of aggregate is required to be corrected. Rolling begins immediately behind the aggregate spreader and continues until at least three complete roller passes have been made. The first roller application is required to be completed within 2 min of the aggregate application. Final rolling is required to be completed within 30 min after the cover aggregate is applied.

The finished seal coat is required to exhibit a tightly knit surface one particle thick (single seal), have enough asphalt binder to seat the aggregate 50 to 65 percent of the aggregate particle, and orient the particles on the average least dimension (Figure 10-6). A common tendency is to apply both the aggregate and the asphalt at an excessive rate.



**Figure 10-6. Aggregate Average Least Dimension**

Fuel or hydraulic fluid leaks from the equipment ruin the appearance of the seal coat, cause permanent damage, and are to be avoided. Areas where leaks occur are required to be repaired as soon as possible to minimize permanent damage to the pavement.

Despite precautions, there is usually loose aggregate on the road surface after rolling is completed. The excess coarse aggregate is required to be removed from the mainline pavement surface by brooming no later than the morning after the placement of the seal coat. Care must be exercised during this brooming operation as the asphalt material may not be fully cured at this time. If the broom is allowed to put excessive force on the seal coated pavement, embedded cover aggregate may be swept from the asphalt material and the pavement may require an additional seal coat. A second brooming operation is required prior to opening to unrestricted traffic in accordance with Section **101.33**.

#### ***APPLICATION OF FOG SEAL***

A fog seal (Section **412**) is placed on top of the cover aggregate. The purpose of a fog seal is to lock the cover aggregate into the seal coat, aid the curing, and improve the surface appearance. The weather and calendar requirements associated with a seal coat also apply to the application of a fog seal.

The fog seal is required to be applied uniformly at the appropriate rate. If too little asphalt material is applied or is not applied in a uniform manner, the seal coat cover aggregate will not be locked in as intended. If too much asphalt material is applied, there will likely be friction problems with the pavement surface.

## APPLICATION RATE COMPUTATIONS

### *ASPHALT MATERIAL*

The Specification application rates for asphalt materials are based on material at 60° F. Since the material is applied at a higher temperature and expands in volume when heated, an allowance is required to be made for the increase in volume.

The formula for calculation of the volume at 60° F from a volume at an observed temperature is:

$$V = \frac{V_1}{K (T - 60) + 1}$$

where: V = volume at 60° F.

V<sub>1</sub> = volume at the observed temperature

T = observed temperature in degrees F

K = coefficient of expansion of asphalt material

The coefficient of expansion to be used in making the volume corrections for asphalt emulsion is 0.00025/° F.

Distributors are required to have a gauge for determining the gallons of material in the tank before and after each application. The difference is the amount applied. Weighing the distributor before and after the application is another acceptable method. The weight of asphalt material in the tank may be converted to a volume in gallons with the following formula:

$$G = \frac{W}{S.G \times 8.328}$$

where:

G = volume in gallons at 60° F

W = weight of asphalt material in pounds

S.G. = specific gravity of asphalt material at 60° F

8.328 = the weight of one gallon of water at 60° F

The laboratory report with the certification indicates the specific gravity and the weight per gallon at 60° F for all asphalt materials.



Example #1 – Determine application rate

Plan rate of application of asphalt material is 0.32 gal/yd<sup>2</sup> at 60° F

Temperature of the asphalt in the distributor is 270° F

$$K = 0.00025$$

$$V_1 = V (K (T-60) + 1)$$

$$V_1 = 0.32 (0.00025 (270-60) + 1)$$

$$V_1 = 0.34 \text{ gal/yd}^2 \text{ at } 270^\circ \text{ F}$$

Example #2 – Determine distributor speed

The speed of the distributor and length of spread are determined before spraying starts. The distributor speed may be determined by the following formula.

$$V = \frac{9Q}{WA}$$

where: V = road speed in feet per minute

Q = spray bar output in gallons per minute

W = spray bar width in feet

A = application rate in gallons per square yard at the application temperature (as computed in Example #1)

Asphalt material as in Example #1

Spray bar width = 12 feet

Pump capacity = 325 gallons per minute

$$V = \frac{9 \times 325}{12 \times 0.34} = 713 \text{ feet per minute}$$

Example #3 – Determine actual application rate

Width of application = 12 feet

Beginning station = 10+00

Ending station = 15+75

Gallons in tank at start = 1230

Gallons in tank at end = 960

Temperature in the distributor = 270° F

$$\text{Area covered} = \frac{12 (1575 - 1000)}{9 \text{ ft}^2/\text{yd}^2} = 767 \text{ yd}^2$$

$$\text{Application rate} = \frac{1230 - 960}{767} = 0.35 \text{ gal/yd}^2 \text{ at } 60^\circ \text{ F}$$

$$V = \frac{V_1}{K (T - 60) + 1} = \frac{0.35}{0.00025 (270 - 60) + 1} = 0.33 \text{ gal/yd}^2 \text{ at } 60^\circ \text{ F}$$

The actual rate of application is 0.33 gal/yd<sup>2</sup> which is slightly higher than the planned rate of 0.32 gal/yd<sup>2</sup>; however, this amount is within reasonable tolerances.

#### Example #4 – Convert weight to gallons

Weight of asphalt material = 14,000 lb

Specific gravity at 60° F = 0.980

$$V = \frac{14,000}{0.980 \times 8.328} = 1715 \text{ gallons at } 60^\circ \text{ F}$$

### **COVER AGGREGATE**

Application rates for cover aggregate are determined in a similar manner as the application rates of asphalt material.

#### Example #5 – Determine the cover aggregate application rate

Weight of cover aggregate applied = 15,200 lb. (from weigh tickets)

Use the area covered from Example #3

$$\text{Application rate} = \frac{\text{quantity used}}{\text{area covered}} = \frac{15,200}{767} = 20 \text{ lb/yd}^2$$

The actual rate is compared with the planned rate. Adjustments in the gate opening are required to reduce or increase the actual rate to conform to the planned rate.

Test runs are required to be made to check the application rates of both the asphalt and cover aggregate prior to commencing sealing operations.

### ***FOG SEAL***

The fog seal application rate adjusted for temperature is calculated in the same manner as seal coat asphalt material in Example #1. The required fog seal distributor speed calculation is made in the same manner as Example #2. The actual fog seal application rate is calculated in the same manner as Example #3.